The Thermodynamics of a Ramjet

Drake, G.* Honeysett, R.†, Johnston, C.‡, Khela, M.§
University of Edinburgh
Email:*s1792587@ed.ac.uk †s1711116@ed.ac.uk, ‡s1711493@ed.ac.uk,
§s1709582@ed.ac.uk

Fig. 1: A NACA engineer cleaning a ramjet circa. 1950 [1]

I. Introduction

A ramjet is an airbreathing engine which uses forward motion to compress air against a static conical compressor. As such, it can only generate thrust when already in motion. A typical ramjet operates from speeds of Mach 3 to Mach 6. This report will analyse a ramjet through the lens of thermodynamics, using idealised Brayton cycles to dissect the sections of the jet and the state variables in each section.

II. The Ramjet

a) Inlet: test
b) Combustion Chamber:
c) Nuzzles your Ramjet: UwU OwO Owo vWv

III. Efficiency

The efficiency of the ramjet is the ratio of the propulsive power to the fuel power. [2]

$$\eta = \frac{Tv}{\dot{m}_f h}.$$

To derive a working expression for the efficiency, consider the thermal and propulsion aspects of the efficiency individually.

$$\eta = \eta_{thermal}\eta_{propulsive}$$

where

$$\eta_{thermal} = \frac{\Delta E_K}{\dot{m}_{fuel} h} \; \eta_{propulsive} = \frac{Tv}{\Delta E_K} \text{ where}$$
$$E_K = \text{Kinetic energy (J)}$$
$$\dot{m}_{fuel} = \text{Rate of fuel burned } (kgs^{-1})$$
$$h = \text{Fuel energy per unit mass } (Jkg^{-1})$$
$$T = \text{Thrust (N)}$$
$$v = \text{Velocity of the air entering the ramjet } (ms^{-1})$$

IV. Conclusion

References

[1] "Naca technician cleans a ramjet in 8- by 6-foot supersonic wind tunnel." [Online]. Available: https://images.nasa.gov/details-GRC-1950-C-25677?fbclid=IwAR1I4lLNCj8oFRWki7opYtk2FaSyQSROFKWyJmHVG05pxn6B_ouRdWINMkY

[2] E. M. Greitzer, Z. S. Spakovsky, and I. A. Waitz, "Thermodynamics and propulsion." [Online]. Available: https://web.mit.edu/16.unified/www/FALL/thermodynamics/notes/node5.html?fbclid=IwAR3QVlgB0fjngD5RBdyfagJfwAThyay9EKtlKq1ivHGmFd_BrGeYABrSVvQ